1.0 INTRODUCTION

1.1 BACKGROUND

In 1995, Cole Associates, Inc. completed the "Juday Creek Watershed Management Plan." To explore the feasibility of the watershed management plan's general recommendations, the St. Joseph County Drainage Board applied for and received a grant from the Indiana Department of Natural Resources (IDNR) Lake and River Enhancement program (LARE). The Drainage Board hired J.F. New & Associates (New) to study the feasibility of selected Best Management Practices (BMPs) for specific stream reaches (Reaches 1 through 7 on Figure 1) of Juday Creek in St. Joseph County, Indiana.

1.2 SCOPE OF STUDY

The scope of the study encompasses the entire Juday Creek channel from the St. Joseph River to Granger, Indiana and its adjacent Drainage Board right-of-way. Historically, Juday Creek likely possessed good to excellent water quality. Agricultural, commercial, and residential development of the watershed has impaired the stream's original habitat. Development of a watershed typically increases silt loads, peak flows, and temperatures in a stream, all of which may impact the stream's biological community. In March 2001, J.F. New (New) conducted a field survey to assess both existing and potential site improvements on Juday Creek. New examined each stream reach in detail. Through public meetings (Appendix A) and from the field survey (Appendix B), New developed a list of all potential BMP's. After review, the list was condensed to nine proposed projects (Figure 1). The following are projects included in this study:

1. Stabilization/habitat improvement west of Brooktrails Drive
2. Erosion control surrounding stormwater outlet at Kenilworth Road
3. Stream reroute/wetland filter (southeast side of Interstate 80/90 at US 933)
4. Stream reconstruction/wetland filter between Ironwood and Douglas Roads
5. Pond fill/constructed stream channel (Douglas Road east of Ironwood)
6. Habitat improvement from Edison Lakes Parkway to Fir Road
7. 30-foot filter strips from Capitol Avenue to Interstate 80/90
8. Infiltration trench on the south side of Interstate 80/90
9. Regraded slope/bank stabilization of ditch north of Interstate 80/90

1.3 OBJECTIVE

The objective of this feasibility study was to locate, conceptually design, and foster the development of potential projects that will improve water quality and fish habitat in Juday Creek.

2.0 DESCRIPTION OF STUDY AREA

2.1 LOCATION

The Juday Creek Watershed (8 Digit-HUC 04050001), encompassing 37.7 square miles (24,128 acres), is located in St. Joseph County, Indiana and Cass County, Michigan (Figure 1). The 12-mile long stream originates in a small wetland in Granger, Indiana and immediately flows through agricultural fields in Reach 1. From Reach 1, the stream flows through residential and commercial development in Reaches 2 through 6. In Reach 7, near the stream's confluence with the St. Joseph River, Juday Creek winds through approximately 300 feet of natural woodland maintained by the St. Joseph County Chapter of the Izaak Walton League of America (Lamberti and Berg, 1995).

2.2 GEOLOGIC HISTORY

The Juday Creek drainage basin formed during the most recent glacial retreat of the Pleistocene Era. The glacial advance and retreat of the Huron-Saginaw Lobe of the last Wisconsian glaciation shaped much of the present topography within the watershed and the northern two-thirds of Indiana (Wayne, 1966). The broad, flat to rolling glaciated plain left by the retreat of the Huron-Saginaw Lobe includes glacial fill and outwash, sandy gravelly beach ridges, and flat belts of morainal hills and bog kettle depressions (Simon, 1997). Many of these features are visible on the Juday Creek Watershed landscape today. This geologic history defines the watershed's ecoregion and shapes the current land use in the watershed.

LAND USE

The Juday Creek Watershed has suffered from impacts of both agriculture and urbanization. Prior to settlement, the area was a mix of natural oak-hickory forest and wetlands. Settlement resulted in forests being cleared, wetlands being drained, and streams being straightened in an attempt to farm the rich soils. Today, row crop agriculture accounts for approximately 40% of the land use (Table 1, Figure 2). Pasture/hay, low intensity residential, and deciduous forest are also important components of land use within the watershed. The land uses cover 20%, 18%, and 14% of the watershed, respectively (Table 1, Figure 2). Refer to Figure 2 for a complete Juday Creek Watershed land use map.

TABLE 1. Land use in the Juday Creek Watershed.

Land Use	Acres	%
Row crops	5,898	40.0
Pasture/hay	2,964	20.0
Low intensity residential	2,623	18.0
Deciduous forest	1,986	14.0
High intensity: commercial/ind/trans	477	3.0
Transitional	226	1.5
High intensity residential	168	1.0
Other grasses (urban/rec. parks)	104	1.0
Woody wetlands	78	<1
Evergreen forest	67	<1
Open water	34	<1
Emergent herbaceous wetlands	24	<1
Mixed forest	9	<1
TOTAL	**14,658**	**100**

Source: USGS/EROS Indiana Land Cover Data Set, Version 98-12 (updated December 1998)

2.3 SOILS

Soils in the Juday Creek Watershed developed primarily under the influence of deciduous forest vegetation and originated from glacial drift and till. Soils are predominantly loams and sandy loams, which are well drained and have good productivity. See Table 2 for a list of soil series found in the Juday Creek Watershed.

TABLE 2. Soil series in Juday Creek Watershed.

Soil Series	Acres	%
Coloma	9,206	63.0
Maumee	5,452	37.0
TOTAL	**14,658**	**100**

Source: STATSGO Database

Coloma Series

The Coloma series consists of somewhat excessively drained, rapidly permeable soils located on outwash plains and moraines. These soils formed from sandy parent material. Slopes range from 0 to 12 percent.

Maumee Series

The Maumee series consists of deep, very poorly drained, nearly level and depressional soils on outwash plains. These soils are mainly on low depressional flats and along stream channels. They formed in sandy glacial outwash or stream alluvium. Maumee soils have rapid permeability and a low available water capacity. The organic-matter content is high in the surface layer. Runoff is very slow or ponded. The majority of the Maumee soils adjacent to Juday Creek have been drained for farming and subsequently developed for residential or commercial use.

2.5 PREVIOUS PROJECTS

Juday Creek has been the key focus of restoration efforts from numerous public and private agencies in the St. Joseph County region, due primarily to the poor health of its introduced brown trout population. In 1994, the St. Joseph River Basin Commission released a diagnostic summary of the Juday Creek Watershed. Following this release, Cole Associates produced the Juday Creek Watershed Management Plan in October 1995. The study plan identified seven distinct stream reaches, as shown in Figure 3. Cole Associates recommended Best Management Practices in each stream reach. Following the study, various agencies implemented a number of projects in order to improve the health of the Juday Creek. All improvement projects along Juday Creek have been compiled into a single database. Each project has been assigned an arbitrary number for identification purposes. Table 3 presents a list of all projects completed to date, while Figure 3 depicts the location of each project site.

TABLE 3. Juday Creek restoration projects.

Project #	Project Type
1	In-stream habitat improvements (Lunker structures)
2	Stormwater filter
3	Street re-routing/in-stream habitat improvements
4	Retro fit storm lines, construct berms and enhance vegetation
5	Sediment trap, deep water basin
6	Redirect storm line, vegetation strip, enhancement of natural wetland
7	Sediment trap, vegetation strip
8	Redirect storm line, vegetation strip, sediment trap
9	Vegetation strip, redirection of stormwater
10	Sediment trap, vegetation strip, deep detention basin
11	Retrofit storm lines, sediment trap, constructed wetland
12	Retrofit storm lines, sediment trap, constructed wetland
13	Wetland filter
14	Vegetate stream banks
15	Mitigation Wetland
16	Constructed wetland, stormwater filter
17	Lunker/log treatment
18	Stream bank improvement, in-stream habitat, stream buffer
19-55	Bank stabilization/erosion control (biologs)

2.6 PRIOR STUDIES ON JUDAY CREEK

Agencies including Limno-Tech, Inc., University of Notre Dame, U.S. Geological Survey, Cole Associates, Indiana Department of Natural Resources, J.F. New and Associates, Inc., and the City of Elkhart have completed studies to aid in the ecological restoration of Juday Creek. The following list summarizes these studies.

A. Limno-Tech, Inc. studied the potential thermal impacts of detention basins along Juday Creek (Limno-Tech, 1991).

B. The University of Notre Dame Department of Civil Engineering and Geoscience (CE/GEOS) studied the effects of groundwater on the stream (Silliman, 1994). This study involved the installation of groundwater wells at various locations along the stream. Researchers examined the physical and chemical qualities of the groundwater and recorded groundwater depth during various time periods.

C. The University of Notre Dame Department of Biology (BIOS) conducted physical and biological surveys at 10 locations along Juday Creek (Runde, 1994). The study focuses on determining the present and future habitability of trout and macroinvertebrates.

D. The U.S. Geological Survey installed a stream gage to monitor flow and discharge from Juday Creek into the St. Joseph River (Fowler and Wilson, 1995).

E. Cole Associates, Inc. produced a watershed management plan for the Juday Creek watershed (Cole Associates, Inc., 1995). The plan reviews old studies, lists management goals, recommends Best Management Practices, and presents implementation strategies.

F. The Natural Resources Conservation Service conducted an evaluation to assess erosion on a stretch of the stream in the northeast ¼ of Section 32, Township 38N, Range 3E of Clay Township on St. Joseph County.

G. J.F. New and Associates, Inc. conducted a biological survey to examine the effects of in-stream habitat improvements on fish and macroinvertebrate communities adjacent to commercial development along US 933 (J.F. New and Associates, unpublished).

H. J.F. New and Associates, Inc. conducted a study of the stormwater discharges to Juday Creek (J.F. New and Associates, Inc., unpublished). The study suggests discharge alternatives and remediation strategies for nine sites along the stream.

I. J.F. New and Associates, Inc. conducted a biological survey at two locations in Juday Creek to examine the existing fish, macroinvertebrate, and botanical communities prior to construction of Best Management Practices (J.F. New and Associates, Inc., 2001).

J. In 2001, during the production of this document, the City of Elkhart – Waste Water Treatment Plant, under contract with the City of South Bend, conducted a fisheries survey of Juday Creek (Joe Foy, personal communication). The survey results were not available as of this printing.

3.0 RECOMMENDED PROJECTS/FEASIBILITY ANALYSIS

3.1 STABILIZATION/HABITAT IMPROVEMENT WEST OF BROOKTRAILS DRIVE

3.1.1 Site Description and Alternatives

A 720-foot stretch of Juday Creek flows north through residential property just west of and parallel to Brooktrails Drive, approximately 500 feet north of Cleveland Road in stream Reach 7 (Figure 1). The field survey of Juday Creek (Appendix B) noted localized bank erosion, a seawall, streamside ponds, and a poorly vegetated buffer zone. Localized bank erosion is occurring due to poorly vegetated banks. A seawall minimizes bank erosion, but decreases aesthetic value and offers little habitat for fish and macroinvertebrates. A channel on the west side of the stream flows through two ponds then discharges back into Juday Creek. The ponds have accumulated silt to a maximum depth of two feet. These ponds release warmwater to the stream and do not support high quality fish communities. A poorly vegetated buffer zone in this reach offers excellent geese habitat.

The alternative treatment types considered include:

1. Correct localized instabilities using biolog installations.
2. Correct bank erosion using riprap.
3. Correct instabilities using bioengineered techniques
4. No action.

Alternative 1 involves the installation of vegetated biologs to reduce bank erosion. This alternative is feasible but would require that landowners refrain from mowing to the stream's edge. Biolog installations may reduce bank erosion. The field survey of Juday Creek (Appendix B) revealed that at best, biologs are marginally effective at improving fish or macroinvertebrate habitat. Under Alternative 2, riprap would be placed along the banks within the entire project reach. This option is feasible but reduces aesthetic value and does not alleviate the poorly vegetated buffer zone. Alternative 3 involves stabilizing all priority areas within the study reach using techniques such as glacial stone armor, weirs, grade controls, bioengineered techniques (soil-encapsulated lifts), and lunker structures. Additionally, buffer zones and pond outlets would be planted with a low profile prairie seed mix, shrubs, and emergent wetland vegetation. Alternative 3 would virtually eliminate erosion from the study reach, minimize geese grazing, and provide habitat for fish and macroinvertebrates. Alternative 4 is also feasible. Under this alternative, banks will continue to erode, ponds will continue to release thermal pollutants, and aquatic habitat will remain poor. These considerations indicate Alternative 3 is the best alternative for treating the observed problems at this location.

3.1.2 Preliminary Design

Alternative 3 corrects all priority areas within the study reach (Figure 4). Glacial stone armor placed around localized erosion at the channel inlet to the south pond and an existing footbridge will eliminate further erosion. Small rock weirs constructed at the channel between the south and north ponds and outlet to Juday Creek will reduce erosion and create riffle habitat beneficial

to fish and macroinvertebrates. Two strategically placed grade control structures will slow water velocity, reducing bank erosion upstream. An existing seawall on the east bank will be removed and replaced with soil-encapsulated lifts planted with a bank stabilization seed mix. Clean fill material taken from pond dredging will be used to construct the lifts. After dredging, the ponds will have a maximum depth of 10 feet, a more suitable depth for warmwater, lentic fish species. Two lunker structures placed near existing streamside trees will function as artificial undercut banks, a natural stream feature and excellent fish attractor. A 25-foot buffer zone on the east bank and 75-foot buffer on the west bank planted with a low profile prairie seed mix will minimize geese grazing and stabilize the bank soils. Additionally, emergent vegetation planted near pond outflows will filter nutrients from water before entering Juday Creek.

3.1.3 Permit Requirements

The proposed project requires four permits before construction can begin. Approval is needed from the U.S. Corps of Engineers (CORPS), the Indiana Department of Environmental Management (IDEM), the Indiana Department of Natural Resources (IDNR), and the St. Joseph County Drainage Board. See Appendix D, subsections 1 and 2 for state and federal agencies' comments regarding the project. Permits will likely take six months to one year to obtain. Permit application forms can be found in Appendix C.

3.1.4 Landowner Agreements

The landowner has verbally agreed to the project.

3.1.5 Social Costs

The proposed alternative has several unusual social costs associated with the construction process and the end result. The landowner will need to evaluate whether the change in the view of the creek would be positive or negative. Fishing opportunities in the stream and ponds could increase. Some trees may be removed or damaged as part of the construction process. Noise levels will increase during the construction period. Construction equipment may damage maintained lawns. During the construction period, storage of materials including rock, earth, fabric, straw, and vehicles will affect the property aesthetics. The existing septic system in the lawn must be marked and avoided during the construction phase. A thorough survey of the area prior to design will help avoid future problems.

3.1.6 Environmental Assessment

Historical surveys documented fish and macroinvertebrate communities downstream from the proposed project site. Runde (1994) surveyed the fish and macroinvertebrates at two locations on the Izaak Walton League property and found no endangered, threatened, or rare (ETR) species. Lamberti and Berg (1995) also conducted fish and macroinvertebrate surveys on the Izaak Walton League property. They found no ETR species that might be affected by work upstream. It is expected that during project construction, there will be temporary negative impacts to biological communities such as silt deposition and removal of existing vegetation. After construction, the project is expected to positively benefit biological communities by reducing sediment loads and stabilizing bank soils. Additional aquatic habitat and planting of native vegetation should provide areas that support more fish, macroinvertebrates, and botanical species than what currently exists.

3.1.7 Cost Estimate

Bank stabilization/habitat improvement at the project site is expected to cost $106,724 (Table 4).

TABLE 4. Bank stabilization/habitat improvements cost estimate.

Item	Cost	Unit	Quality	Total
Low profile prairie mix	$4,500	Installed	1	$4,500
Red-osier dogwood	$30	Per plant	20	$600
Soil-encapsulated lifts	$75	Per foot	720	$54,000
Glacial stone	$25	Cubic yard	274	$6,850
Excavate ponds/fill material	$7	Cubic yard	100	$700
Erosion and sediment control	$2,500	Lump sum	1	$2,500
Mobilization/demobilization	$2,000	Lump sum	1	$2,000
Construction sub-total				**$71,150**
Engineering, design, and permitting	15%	Construction costs		$10,672
Construction oversight	10%	Construction costs		$7,115
Contingency	25%	Construction costs		$17,787
Total				**$106,724**

3.2 EROSION CONTROL SURROUNDING STORMWATER OUTLET AT KENILWORTH ROAD

3.2.1 Site Description and Alternatives

Kenilworth Road is a residential street maintained by the St. Joseph County Highway Department. The road crosses Juday Creek approximately 250 feet north of Cleveland Road in stream Reach 7 (Figure 1). The field survey of Juday Creek (Appendix B) noted that 60 square feet of bank has eroded away around a stormwater outlet pipe on the northwest side of Kenilworth Road. The bank has eroded back to the next section of a 24- inch concrete drainage pipe, leaving the first section lying on the stream bottom. The erosion is most likely caused by the discharge of stormwater from the concrete pipe and the subsequent turbulence within Juday Creek.

The alternatives considered for fixing this erosion area include:

1. Placing the collapsed section of pipe on top of a riprapped stabilized toe and resloping and seeding the bank above the pipe.
2. Placing a concrete or sheet pile head wall at the original bank location, backfilling and replacing the collapsed section of pipe.
3. No action.

Alternative design 1 provides the most stability while creating a natural bank appearance. Alternative 2 is feasible but reduces aesthetic value and does not improve habitat. Alternative 3 is also feasible. Under this option, erosion will continue around the stormwater outlet pipe. A review of the three alternatives indicates Alternative 1 is the best option for treating the eroding stormwater outlet.

3.2.2 Preliminary Design

Under Alternative design 1, the outlet pipe will be stabilized with riprap while the banks will be planted with deep-rooted vegetation. Figure 5 depicts a plan view of the riprap base, which extends into Juday Creek 1.5 feet. Figure 6 represents a cross section of the pipe extension and regarding plan. The riprap extension acts as a groin to push the current away from the outfall, thereby reducing the turbulence. The riprap will be underlain by a non-woven geotextile liner to prevent ground water discharge from leaching through the riprap. The collapsed section of pipe will be seated directly on the riprap and held in place by topsoil graded to a 3:1 slope from the invert to the top of the existing bank. The slope will be seeded with a mix of grasses that have deep and extensive root systems for long-term stabilization. The seed is held in place by a coconut and straw erosion control blanket installed per the manufacturer recommendations.

3.2.3 Permit Requirements

A construction in a floodway permit is typically required for all work in a regulated floodway such as Juday Creek. Assuming the St. Joseph County Drainage Board performs the work, it will be considered maintenance of an existing drain and will not require permits from IDNR, the CORPS, or IDEM. If the St. Joseph County Drainage Board does not perform the work, the CORPS has jurisdiction over Juday Creek as a "waters of the United States". The CORPS has issued Regional General Permits (RGP) for minor activities (0.10 acres or less) within its jurisdiction. This project qualifies for a RGP and must be submitted to IDEM and IDNR. IDEM requires that projects within "waters of the state" that "discharge pollutants" (including fill) get authorization from the agency under Section 401 or 402 of the Clean Water Act. This project meets the requirements for notification under Section 401 water quality certification. Notification only requires a 15-day waiting period. The notification form is attached in Appendix C. The St. Joseph County Drainage Board will need to approve this project, as Juday Creek is a legal drain. See Appendix D, subsections 1 and 2 for state and federal agencies' comments regarding this project.

3.2.4 Landowner Agreements

The project is within the St. Joseph County Drainage Board's jurisdiction. The Drainage Board has verbally agreed to complete the project with its own funding.

3.2.5 Social Costs

There are limited social costs associated with this project. It is a one-day project requiring no long-term maintenance. There may be some temporary disturbance caused by installing the filter fabric and riprap, but this disturbance is expected to be limited.

3.2.6 Environmental Assessment

A plant survey of the area found no restorable vegetation. Adjacent vegetation includes silky dogwood and lawn grasses. Only the lawn grasses will be impacted by the project. Runde (1994) surveyed macroinvertebrates at Kenilworth Road as part of Notre Dame's biological reconnaissance of Juday Creek. The study found no ETR macroinvertebrate species that might be affected by construction work within the stream. Runde (1994) and Lamberti and Berg (1995) collected macroinvertebrates and fish downstream of Kenilworth Road on the Izaak Walton League property and found no ETR species that might be affected by work upstream. This project is expected to have a minimal positive affect on fish and macroinvertebrates by creating additional habitat.

3.2.7 Cost Estimate

The probable cost of construction at Kenilworth Road, assuming the work is completed under the supervision of the St. Joseph County Drainage Board, is $750 (Table 5).

TABLE 5. Kenilworth Road cost estimate.

Item	Cost	Unit	Quantity	Total
Excavation/hauling	$8.50	Cubic yard	12	$100
Rip-rap	$20	Ton	10	$200
Back fill	$10	Ton	15	$150
Coconut straw fabric	$200	1 roll (installed)	1	$200
Seed	$50	Lump sum	1	$50
Staples	$50	Lump sum	1	$50
Total				**$750**

3.3 STREAM REROUTE/WETLAND FILTER (SOUTHEAST SIDE OF INTERSTATE 80/90 AT US 933)

3.3.1 Site Description and Alternatives

Juday Creek flows west approximately 200 feet south of and parallel to Interstate 80/90, approximately 20 feet north of the Hospice of St. Joseph County in stream Reach 7 (Figure 1). The field survey (Appendix B) noted several stormwater outlets originating from parking lots and US 933. Collectively, these outlets deliver unfiltered stormwater into Juday Creek.

The alternative treatment types considered include:

1. Gravel/sand filters at the spillways.
2. Mechanical in-line separators or filtration bags.
3. Stream reroute and wetland filter.
4. No action.

A lack of space for several of the intended discharge points renders Alternative 1 infeasible. Alternative 2 is not feasible because it is cost prohibitive and requires long-term frequent maintenance. Alternative 3 is feasible. Water quality benefits resulting from a stream reroute/constructed wetland filter include reduced sediment, thermal pollution, road salts, and petroleum products. The proposed project under this option provides the most benefit to the stream's health for the lowest long-term cost. Alternative 4 is also feasible but does not improve water quality in the stream. Analysis of the four alternatives revealed Alternative 3 as the best option.

3.3.2 Preliminary Design

A stream reroute/wetland filter provides a natural look, blends into the environment, and requires little maintenance. Figures 7 and 8 depict conceptual and cross sectional plan views of the stream reroute/wetland filter and some additional streambank erosion control and enhancement upstream. To avoid removing buildings, approximately 300 feet of Juday Creek will need to be routed north of its current alignment just east of US 933. The stream will be rerouted using the

design concepts and parameters utilized in the Notre Dame Golf Course project upstream. The stormwater will be routed from current discharge points along US 933 and the Hospice Center parking lot into a 30 to 50-foot wide by 250-foot long gravel bottom constructed wetland. The constructed wetland filter will drain eastward to discharge to Juday Creek. These filtration wetlands typically remove up to 90% of the solids and 45-75% of the phosphorus, nitrogen, and petroleum compounds (Cooke et al., 1993). Additional design plans will be required to proceed with the project.

3.3.3 Permit Requirements

This project will require the approval of IDNR, IDEM, CORP, and the St. Joseph County Drainage Board. See Appendix D, subsections 1 and 2 for state and federal agency's comments regarding the project. Permit application forms can be found in Appendix C.

3.3.4 Land Owner Agreements

B & R Oil Company owns the land on which the proposed wetland would lie. The owner of B & R Oil generally supports the project. See Appendix D, subsection 3B for communication between New and B & R Oil Company.

3.3.5 Social Costs

The loss of available land is the only social cost associated with this project. The land north of the stream to Interstate 80/90 is currently unused; it lies in a regulated floodway. The wetland filter will be constructed in or adjacent to the north side of the existing Juday Creek channel. This may benefit the owner of the property by allowing the use of more ground on the south side of the existing stream. Construction access will be gained through the existing developed B & R Oil company property on the south side of the stream. Construction of the new channel will cause temporary loss of parking and stream crossing. Additionally, some trees may be lost through the construction process. Overall, the project will result in improved fish and macroinvertebrate habitat, more useable space, and improved water quality.

3.3.6 Environmental Assessment

J.F. New & Associates surveyed fish, macroinvertebrates, and vegetation approximately 700 feet downstream from the proposed project site (J.F. New and Associates, unpublished). The study found no endangered or threatened species that will be impacted by construction upstream. The existing project site has good riparian habitat value with the shrubs and trees present along the banks. However, the bottom of the stream is not vegetated, has no riffle or pool structure, and is dominated by sand. Initial construction is expected to have little effect on fish, macroinvertebrate, or plant communities downstream. Post construction conditions are expected to increase habitat value in the relocated stream by providing riffle-pool and well vegetated riparian habitat. Additionally, the project will improve water quality downstream by removing sediment and nutrient loads from stormwater before they enter Juday Creek.

3.3.7 Cost Estimate

The stream reroute/wetland filter is expected to cost $167,400 (Table 6).

TABLE 6. Stream reroute/wetland filter cost estimate.

Item	Cost	Unit	Quantity	Total
Channel reconstruction	$125	Per foot	300	$37,500
Filter construction	$125	Per foot	200	$25,000
Piping of storm water	$50	Per foot	200	$10,000
Install boulders to protect road grade	$50	Per foot	90	$4,500
Erosion and sediment control	$ 5,000	Lump sum	1	$5,000
Mobilization/demobilization	$ 2,000	Lump sum	1	$2,000
Construction sub-total				**$84,000**
Services during construction	10%	Construction	$84,000	$8,400
Contingency	25%	Construction	$84,000	$21,000
Engineering design and permitting	30%	Construction	$84,000	$25,200
Total				**$138,600**

3.4 STREAM RECONSTRUCTION/WETLAND FILTER BETWEEN IRONWOOD AND DOUGLAS ROADS

3.4.1 Site Description and Alternatives

A 1,200-foot stretch of Juday Creek flows northwest largely through residential property between Ironwood and Douglas Roads in stream Reach 4 (Figure 1). The field survey of the stream (Appendix B) noted bank erosion, a sand bottom, and several streamside ponds. Unstable banks in one meander threaten one home's foundation, while streamside ponds act as sources of thermal pollution to the stream. The erosion of both banks and the lack of habitat in the stream channel are a result of sediment deposition and poor riparian vegetation. Within this project reach, Juday Creek flows northwest and crosses Douglas Road approximately 800 feet east of the intersection of Douglas and Ironwood Roads. The field survey of Juday Creek (Appendix B) noted severe erosion around a stormwater outlet that drains water from the north side of Douglas Road into the stream. The outlet is a concrete spillway that connects to Douglas Road at a curb cut just west of the bridge over the stream. The spillway slopes to a steel sheet pile at the waters edge. Stormwater that travels down the concrete spillway scours the area around the spillway. The scour extends to at least three feet beneath the pavement surface of Douglas Road.

The alternative treatment types considered include:

1. Stabilize priority areas using techniques such as glacial stone, coconut fiber logs planted/seeded with native vegetation, and woody debris structures.
2. Reconstruct the entire project area by narrowing the channel, restoring meanders, constructing pool habitat, reshaping, and revegetating the banks with native plants. Included in this option is a constructed wetland filter for Douglas Road.
3. Connect the runoff on the north and south sides of Douglas Road and route it to an existing wetland basin at the southeast corner of Douglas and Maple Roads.
4. No action.

Several agencies have implemented Alternative 1 with varying degrees of success throughout the length of Juday Creek. The bank stabilization techniques included in this alternative do not improve habitat for fish and macroinvertebrates. Alternative 2 would completely reconstruct the stream using design techniques similar to those implemented in the Notre Dame Golf Course channel relocation project. These methods produce the best response in terms of improving stream habitat and reducing erosion. Additionally, a wetland filter constructed on the north side of Douglas Road on property owned by the McBrides will remove the sand, salt, and other pollutants that wash off Douglas Road. Alternative 3 involves routing stormwater from the north side of Douglas Road to an existing basin on the south side of the road. This option is not feasible due to the lack of fall between the north side of Douglas Road and the existing basin. Under Alternative 4, the banks would continue to erode and may ultimately damage a home where flows have begun to undermine the foundation. Douglas Road would also remain unsafe with its current stormwater outlet structure. In addition, fish and macroinvertebrate habitat would remain poor and water quality would not improve. These considerations suggest Alternative 2 is the best alternative.

3.4.2 Preliminary Design

The bank stabilization and stream reconstruction techniques utilized in this design include narrowing the existing stream channel with bioengineered bank stabilization techniques (soil-encapsulated lifts), filling existing inflow/outflow channels to streamside ponds, filling portions of the existing stream channel, excavating pools on outside meanders, and placing boulders in the bank toe near Ironwood Road (Figure 9). A narrowing of the existing stream channel will increase flow velocity and keep fine sediments moving through the stream. Backfilling existing inflow/outflow channels to streamside ponds will keep them from filling with fine sediments. Excavating the existing ponds to a depth of eight to 10 feet will create a more suitable habitat for warmwater, lentic fish species. Sediment excavated from ponds will be used to fill an existing side channel that presently threatens a home's foundation. Excavated pools on outside meanders will create holding water for selected fish species and encourage sediment sorting. Boulders placed in the bank toe near Ironwood Road will prevent erosion while providing fish habitat.

In addition to stream reconstruction, a small wetland filter/swale (approximately 0.057 acre) will be constructed on the north side of Douglas Road, just west of Juday Creek (Figure 10). The filter will be designed to serve stormwater from the northern half of the 1,200-foot reach to Ironwood Road. It will be vegetated with wetland plants; maintenance will be minimal including annual inspections to check on the capacity of the system and growth of plants. Construction will include working around the largest of the silver maple trees, which dominate the site. Much of the remaining vegetation at the site is reed canary grass and other non-native plants. The filter is designed to remove the majority of solids and from 45-75% of the nutrient load in the stormwater (Cooke et al. 1993).

3.4.3 Permit Requirements

This project will require the approval of the IDNR, IDEM, CORP, the St. Joseph County Drainage Board, and the County Highway Department. Permits will likely take from six months to one year to obtain. Permit applications can be found in Appendix C. Refer to Appendix D, subsections 1 and 2 for state and federal agencies' comments regarding the proposed project.

3.4.4 Landowner Agreements

There are six landowners in the project reach. Five of the landowners live north of Juday Creek on Edgewood Walk. The other landowner lives south of the stream at the northeast corner of Ironwood and Douglas Roads. All landowners have agreed to support the proposed project (Appendix D, subsection 3C).

3.4.5 Social Costs

The proposed alternative for this reach has several unusual social costs associated with the construction process and the end result. Property lines run through the center of the stream, as it exists now or has existed some time in the past. All owners must hire a surveyor to establish permanent property lines that may or may not follow the centerline of a newly aligned channel. Each owner who agrees to this project needs to consider whether the change in his or her view of the creek is positive or negative. Fishing opportunities should increase. Fishing may be considered a positive or negative to each owner. Some trees may be removed or damaged as part of the construction process. Property values should increase especially for the homeowner who has a failing foundation. There will be a temporary noise and people traffic issue during the three to four months of construction that must be considered. Construction equipment may damage maintained lawns. Existing septic systems in these lawns will be marked and avoided during the design phase and construction phase. A survey of these areas prior to design will help avoid future problems. Some fences will need to be repaired at the projects conclusion. Storage of construction materials including rock, earth, fabrics, straw, and vehicles will affect at least one owner's ability to use their property.

3.4.6 Environmental Assessment

J.F. New surveyed the fish, macroinvertebrates, and plants along Juday Creek between Ironwood and Douglas Roads in October 2001 (Appendix E). The study found no ETR species that might be affected by work within the stream. Lamberti and Berg (1995) also surveyed biological communities in a similar residential area and found no ETR species. It is expected that during project construction there will be temporary negative impacts to biological communities. After construction, the project is expected to positively benefit biological communities. A reduction in sediment and heated water discharge, more available fish and macroinvertebrate habitat, and planting of native plant species should provide habitat that supports a more diverse biological community than what currently exists.

3.4.7 Cost Estimate

The probable cost of stream reconstruction and a wetland filter between Ironwood and Douglas Roads is $357,284 (Table 7).

TABLE 7. Probable cost estimate for stream reconstruction/wetland filter (Douglas Road to Ironwood Road).

Item	Cost	Unit	Quantity	Total
Construct new pools for fish habitat	$300	Each	11	$3,300
Soil-encapsulated lifts	$75	Per foot	730	$54,750
Install boulders to protect road grade	$50	Per foot	90	$4,500
Stone	$25	Cubic yard	20	$500
Construct new channel meanders	$125	Per foot	480	$60,000
Excavate ponds/filter for fill material	$7	Cubic yard	2,970	$18,200
Fabric, seed, plugs, and misc. (wetland filter)	$8	Square yard	550	$4,440
Clearing and grubbing (wetland filter)	$2,500	Lump sum	1	$2,500
Install native vegetation throughout reach	$12,000	Per acre	6.5	$78,000
Reclaim access roads, site cleanup	$5,000	Lump sum	1	$5,000
Erosion and sediment control	$5,000	Lump sum	1	$5,000
Mobilization/demobilization	$2,000	Lump sum	1	$2,000
Construction sub-total				**$238,190**
Engineering design, surveying, and permitting	20%	Construction costs	$238,190	$47,638
Construction oversight	10%	Construction costs	$238,190	$23,819
Contingency	25%	Percent	$238,190	$59,547
Total cost				**$369,194**

3.5 POND FILL/CONSTRUCTED STREAM CHANNEL (Douglas Road east of Ironwood Road)

3.5.1 Site Description and Alternatives

The proposed project site, located approximately 1,500 feet upstream of Douglas Road's intersection with Juday Creek includes a residence with several acres of vacant land and frontage along Douglas Road. The site contains an ornamental pond. Water from the stream flows through a side channel into the pond. Over the years, up to two feet of silt has accumulated in the 0.3 acre pond. In dry summers, the pond contains no water. Water from the pond discharges into a neighbor's pond to the west, then into Juday Creek to the south. Thermal pollution from the pond impairs the stream habitat. In addition, due to the pond's shallow depth, it is incapable of supporting fish. The owner approached the study team for solutions.

The alternatives considered included:

1. Completely fill in the ponds and channel.
2. Fill the ponds to the point of maintaining a single channel to the neighbors' ponds.
3. No action.

Alternative 1 would be of the most value to the stream; however, the owner would lose all of the aesthetic value that the waterway/pond add to the residential lot. Alternative 2 would reduce thermal pollution, increase fish habitat, and preserve the aesthetic value of the stream. Alternative 3 would not benefit the stream or the landowner.

3.5.2 Preliminary Design

Alternative 2 will involve filling in the majority of the pond that now exists on the property (Figure 11). A conveyance channel will remain to carry water to the neighbor's pond, who was not contacted during this study. Depending upon the owner's final design choices, the remaining channel on the property will be stabilized with stone or vegetation established on coir fiber lifts. If desired by the landowner and regulatory agencies, gravel could be placed on the bottom of the channel, overhanging trout habitat structures (lunkers) could be built into the banks of the newly established two to three foot wide channel, and native vegetation could be planted on the channel banks. The project is designed to limit the thermal pollution from the ponds. However, habitat improvement is an important secondary goal. Figure 12 represents a conceptual rendering of the completed project.

3.5.3 Permit Requirements

This project will require the approval of the IDNR, IDEM, CORPS, and the St. Joseph County Drainage Board. See Appendix D, subsections 1 and 2 for state and federal agencies' comments regarding the project. Permit application forms can be found in Appendix C.

3.5.4 Landowner Agreements

One landowner will be affected by this proposal. The landowner has agreed to support the project. See Appendix D, subsection 3D for communication between New and the landowner. Adjacent landowners will be involved in final designs and permitting.

3.5.5 Social Costs

The proposed alternative has limited social costs associated with the construction process and the end result. The aesthetic value of the existing pond will be partially or entirely lost depending upon the design chosen. Fishing opportunities will likely change from pond-oriented fish communities to stream-oriented fish communities. It is unlikely that the work will affect property values. Increased noise and people traffic is expected during the one to two month estimated construction time. Construction access is through the owner's maintained lawn. Storage of construction materials including rock, earth, fabrics, straw, and vehicles during the construction period will affect the owner's ability to use the property. Additionally, the existing septic system will be marked and avoided during the design phase and construction phase. At this time, the exact location and condition of the septic system is unknown.

3.5.6 Environmental Assessment

Lamberti and Berg (1995) surveyed biological communities in a similar residential reach of Juday Creek. The study found no ETR species that might be affected by work within the stream. J.F. New also surveyed biological communities including fish, macroinvertebrates, and plants approximately 2,000 feet downstream between Douglas and Ironwood Roads (Appendix E). No ETR species were observed. It is expected that little or no impact will occur during or following construction as the newly constructed channel can be completely sealed off from Juday Creek.

The project's long-term goal is to benefit biological communities by reducing thermal pollutants to the stream, reintroducing native plant species to the channel banks, and increasing in-stream habitat for fish and macroinvertebrates.

3.5.7 Cost Estimate

The probable cost of construction for pond fill/construction of a stream channel on the property is $71,300 (Table 8).

TABLE 8. Pond fill/constructed stream channel cost estimate.

Item	Cost	Unit	Quantity	Total
Earth for backfill	$15	Cubic yard	700	$10,500
Stone	$25	Cubic yard	50	$1,250
Fabric, seed and assoc. supplies	$3,500	N/A	N/A	$3,500
Construction of channel	$125	Foot	230	$28,750
Mobilization and demobilization	$2,000	Lump sum	-	$2,000
Services during construction	10%	Construction costs	$46,000	$4,600
Engineering	15%	Construction costs	$46,000	$6,900
Contingency	20%	Construction costs	$6,000	$13,800
Total				**$71,300**

3.6 HABITAT IMPROVEMENT FROM EDISON LAKES PARKWAY TO FIR ROAD

3.6.1 Site Description and Alternatives

Approximately 4,700 feet of Juday Creek flows west between Edison Lakes Parkway and Fir Road in stream Reach 2 (Figure 1). The majority of this reach flows through residential or agricultural land. The field survey of Juday Creek (Appendix B) revealed that, in general, the stream is wide, channelized, and shallow and contains sand or silt substrates. Additionally, bank erosion was noted throughout the project reach with severe erosion occurring just west of Fir Road. Most of the problems encountered result from the modification of the original stream channel. Benefits of Best Management Practices include reduced sediment loads and potential habitat for fish and macroinvertebrates.

The alternatives considered for improving water quality in this reach include:

1. Protect the banks within the current stream boundaries using glacial stone and woody debris structures.
2. Protect the banks using fiber logs and native vegetation.
3. Reconstruction of the entire reach.
4. No action.

Alternative 1 is feasible. All the work would occur within the existing channel alignment, and the cost would be relatively low compared to other methodologies. Alternative 2 is not considered feasible. The heavy over-story limits light penetration vital to the growth of potential vegetation. Alternative 3 is not feasible because the height of the banks and the cost of excavation would be high relative to the benefits gained. Alternative 4 is feasible; however, the

water quality impacts from erosion would not decrease and the habitat would not improve without human intervention. After consideration, Alternative 1 was pursued.

3.6.2 Preliminary Design

Meandering the stream within its current boundaries using glacial stone and woody debris structures such as deflector logs, cover logs, and channel constrictors will stabilize the banks while narrowing the existing stream channel. Narrowing the channel will increase sinuosity and flow velocity, keeping fine sediments moving through the stream and exposing the natural gravel bottom. In-stream woody debris structures will also provide excellent habitat for fish and macroinvertebrates. Glacial stone will be installed on the stream banks to reduce erosion and hold woody debris structures in place. Figures 13 and 14 depict plan views of stream meandering/constriction using glacial stone and in-stream woody debris. Due to the project's length and numerous channel modifications, additional detailed plan drawings with precise calculations will be required before the project can proceed.

3.6.3 Permit Requirements

This project will require the approval of the IDNR, IDEM, CORP, and the St. Joseph County Drainage Board. Due to the magnitude of the project, permit evaluations will likely require a detailed plan with precise calculations. See Appendix D, subsections 1 and 2 for state and federal agency's comments regarding the project.

3.6.4 Landowner Agreements

There are 33 landowners that will be affected by this project. Each landowner was sent a letter discussing the project and seeking their support. Several letters have been returned (Appendix D, subsection 3E). All returned letters express interest and approval of the proposed project.

3.6.5 Social Costs

The proposed alternative for this reach has several unusual social costs associated with the construction process and the end result. Each landowner who agrees to this project needs to consider whether the change in his or her view of the stream is positive or negative. Fishing opportunities may increase following construction. This may be considered a positive or negative to each owner. Some trees will be removed as part of the construction process. There will be temporary noise and increased traffic during the one to two months of construction that must be considered. Construction access is through agricultural fields where possible; however, additional access is gained through maintained lawns. During the construction period, storage of construction materials including rock, earth, logs, and fabrics will affect a few owners. Existing septic systems in lawns will be marked and avoided during the design phase as well as the construction phase. A survey of these areas prior to design will help avoid future problems.

3.6.6 Environmental Assessment

Much of the proposed project lies within agricultural or residential land. Biological studies have been conducted in similar reaches throughout Juday Creek. Studies by Lamberti and Berg (1995) and New (Appendix E) indicate that no ETR species are present in similar reaches upstream and downstream from the project location. It is expected that during project construction, there will be minimal effects to the existing biological community. The intended goal of the project is to reduce the amount of sediment entering the stream and narrow the existing stream channel to increase velocity and expose the natural gravel bottom. Additionally, glacial stone and in-stream woody debris installation is expected to increase fish and macroinvertebrate community structure.

3.6.7 Cost Estimate

The probable cost of construction for habitat improvement between Edison Lakes Parkway and Fir Road is $146,450 (Table 9). Note: the number of structures desired can easily manipulate the cost estimate.

TABLE 9. Habitat improvement cost estimate.

Item	Cost	Unit	Quantity	Total
Clearing	$2,500	Lump sum	1	$2,500
Spawning gravel	$175	Yard (installed)	100	$17,500
Woody debris	$600	Per installation	100	$60,000
Excavation	$200	Per installation	100	$20,000
Mobilization/demobilization	$1,500	Lump sum	1	$1,000
Services during construction	10%	Construction costs	101,000	$10,100
Engineering	15%	Construction costs	101,000	$15,150
Contingency	20%	Construction costs	101,000	$20,200
Total				**$146,450**

3.7 30-FOOT FILTER STRIPS FROM CAPITOL AVENUE TO INTERSTATE 80/90

3.7.1 Site Description and Alternatives

The field survey of Juday Creek (Appendix B) revealed that stream Reach 1 consists almost entirely of straight agricultural drainages that are surrounded by row crops. Additionally, little overhead cover or streamside buffer exists throughout the reach. Approximately 4,000 feet of Juday Creek and Scamhorn Ditch (a tributary to Juday Creek) lie between Capitol Avenue and Interstate 80/90 (Figure 1). Like most of the reach, this stretch is channelized through agricultural land with banks averaging six feet high. Installation of 30-foot wide filter strips on either side of both Juday Creek and Scamhorn Ditch will improve water quality by reducing sediment and nutrient loads from entering the stream. Due to the owner(s) desire to continue farming the land, no other alternatives were considered feasible including complete stream reconstruction.

3.7.2 Preliminary Design
A 30-foot filter strip on either side of both Juday Creek and Scamhorn Ditch will total approximately 38 acres (Figure 15). Benefits of filter strips in this reach include reduced sediment and other pollutants (nutrients, pesticides, herbicides) and potential increases in habitat for fish and macroinvertebrates. The design of this filter is limited to recommended grasses specified by the Natural Resource Conservation Service (NRCS).

3.7.3 Permit Requirements
There are no permit requirements for this work.

3.7.4 Landowner Agreements
The only way to implement filter strips is to gain the permission of the landowner(s) or have the landowner(s) enroll in the NRCS's Conservation Reserve Program (CRP) on their own. Four landowners were contacted along the subject reach, first with a letter and then in person to introduce the idea of filter strips. The landowners were provided with information obtained from the NRCS on the amount of money per acre that they would receive from implementing filter strips. The landowners were then encouraged to work with NRCS if they were interested. The individual who owns the greatest land area did initiate the enrollment of their acreage into the filter strip program.

3.7.5 Social Costs
The lost farming acreage and the potential for anglers trespassing on the created filter strips are the only unusual social costs of enrolling land in the filter strip program.

3.7.6 Environmental Assessment
J.F. New & Associates did not survey the fish, macroinvertebrate, and plants communities throughout the entire proposed filter strip area due to the limited amount of water in the upper portion of the stream reach. However, Runde (1994) sampled these communities at Juday Creek's intersection with Bittersweet Road, and J.F. New & Associates sampled the biotic community downstream of the proposed project site, just east of Capitol Avenue (Appendix E). These studies found no ETR species that might be affected by work in the reach. It is expected that the filter strip project will positively benefit fish, macroinvertebrates, wildlife, and plants by reducing the sediment and nutrient loads to the creek, providing more permanent cover on the slopes, and reintroducing native plant species to the area.

3.7.7 Cost Estimate
The probable cost of construction for implementation of 30-foot filter strips between Capitol Avenue and Interstate 80/90 is $21,120 (Table 10).

TABLE 10. Filter strip cost estimate.

Item	Cost	Unit	Quantity	Total
Seeding	$500	Acre	38.4	$19,200
Annual maintenance	$50	Acre	38.4	$1,920
Total				**$21,120**

3.8 INFILTRATION TRENCH ON SOUTH SIDE OF INTERSTATE 80/90

3.8.1 Site Description and Alternatives

A 500-foot swale collects stormwater runoff from the Toll Road and channels it to Juday Creek. The swale parallels the south side of the Toll Road in Granger, Indiana, east of Juday Creek (Figure 1). The swale is currently barren of vegetation in places or dominated by shallow rooted fescue that is mowed throughout the growing season. Because the grass is sparse and mowed, the swale does little to slow or filter any stromwater runoff from the Toll Road.

The alternatives considered included:

1. Wetland swale renovation.
2. Infiltration trench using septic stone.
3. No action.

Alternative 1 would provide the most treatment for stormwater; however, a wetland swale is not compatible with the current maintenance regime. Alternative 2 allows the stormwater to be treated, is compatible with mowing, is inexpensive to install, and requires little maintenance. Alternative 3 is feasible but would not improve water quality in the stream. Based on these considerations, Alternative 2 is the best option to treat the described problem.

3.8.2 Preliminary Design

The proposed project involves the excavation of approximately 110 cubic yards of soil (two feet deep and three feet wide) from the entire existing roadside swale. Specifically, excavation will occur between the stormwater grate and Juday Creek (Figure 16). The trench will be lined with a non-woven geotextile cloth and backfilled to the original swale grade with coarse sand and gravel. The infiltration trench is designed to absorb and filter the majority of stormwater before it reaches the stream. Overflow will travel over the top of the structure as it does now. Any areas outside of the swale disturbed during construction will be seeded with a standard grass mix and covered with straw blankets.

3.8.3 Permit Requirements

The proposed project requires approval from the St. Joseph County Drainage Board and Indiana Department of Transportation (INDOT) (Toll Road District). INDOT (Toll Road District) will solicit bids for an Asphalt Paving Project in the proposed project area in June 2002. INDOT (Toll Road District) approves of the proposed project and would like to include it within their Asphalt Paving Project (Appendix D, subsection 1).

3.8.4 Landowner Agreements

The project will not affect any landowners other than the Toll Road. INDOT approves of the proposed project (See 3.8.3 above). Appendix D, subsection 1 contains a letter of communication between INDOT and New.

3.8.5 Social Costs

There are limited unusual social costs of completing the project. Traffic control will be needed near the project site. Land must also be set aside for storage of construction materials.

3.8.6 Environmental Assessment

J.F. New & Associates inventoried the plants along the existing slope. The plant community consists almost entirely of reed canary grass and fescue. Runde (1994) monitored fish and macroinvertebrates just downstream at Juday Creek's intersection with Bittersweet Road. The study found no ETR species that might be affected by work upstream. In fact, the project is expected to positively benefit fish, macroinvertebrates, and plants by reducing the sediment supply to the creek.

3.8.7 Cost Estimate

The probable cost of construction for the infiltration trench is $9,570 (Table 11).

TABLE 11. Infiltration trench cost estimate.

Item	Cost	Unit	Quantity	Total
Excavation/grading/hauling	$12.50	Cubic yard	110	$1,375
Gravel/sand	$25	Cubic yard	110	$2,750
Seeding	$250	Lump sum	1	$250
Straw blanket	$0.50	Square foot (installed)	3,000	$600
Mobilization/demobilization	$500	Lump sum	1	$500
Traffic control	$2,500	Lump sum	1	$2,500
Contingency	20%	Construction cost	$7,975	$1,595
Total				**$9,570**

3.9 REGRADED SLOPE/BANK STABILIZATION OF DITCH NORTH OF INTERSTATE 80/90

3.9.1 Site Description and Alternatives

A 1,000-foot drainage ditch parallels the north side of Interstate 80/90 in Granger, Indiana, just east of Juday Creek (Figure 1). This ditch has steep slopes (1:1) and is severely eroding due to the sandy soils and limited vegetation. Runoff from the Toll Road and periodic high flows in the ditch has caused most of the observed erosion. Regrading and stabilizing ditch slopes are the primary components of this proposed project.

The alternatives considered for fixing this site include:

1. Riprapping the existing slope.
2. Regrading the banks to form a 3:1 slope and vegetating with prairie grasses
3. No action.

Alternative 1 is not feasible due to the cost, negative effects to the environment, and potential hazards to mowing crews. Alternative 2 is feasible. The regrading of the slope would not only give the ditch more capacity, but would also offer the best chance for grasses to become permanently established on the slopes. Additionally, it would be safer for motorists and mowing crews. Under Alternative 3, the ditch banks would continue to erode. Based on these considerations, Alternative 2 would be the best option.

3.9.2 Preliminary Design

Design Alternative 2 proposes to utilize 25 feet of the existing 50-foot (average) top-of-bank right-of-way space along the north side of the Toll Road (Figure 17). Approximately 5,300 cubic yards of sand will be excavated in order to create a 3:1 slope. The specified seeding (Table 12) will be broadcast directly onto the surface of the soil. Straw/coconut erosion control blankets will be placed over the seed per manufacturer's recommendations. The blankets generally last one to two years before biodegrading. After that point, the specified vegetation should be adequate to protect the slope.

TABLE 12. Grass mix for slope stabilization

Botanical Name	Common Name	Quantity
Permanent Grasses:		
Andropogon gerardii	Big blue stem	16oz
Andropogon scoparius	Little blue stem	40oz
Bouteloua curtipendula	Side-oats grama	3oz
Elymus canadensis	Canada wild rye	1oz
Panicum virgatum	Prairie switchgrass	12oz
Sorghastrum nutans	Indian grass	24oz
Temporary Grasses:		
Agrostis alba	Redtop	10lbs
Avena sativa	Seed oats	25lbs
Festuca rubra (Dawson's)	Dawson's creeping red fescue	10lbs
Lolium multiflorum	Annual rye	25lbs
Phleum pretense	Timothy grass	10lbs

3.9.3 Permit Requirements

The proposed project requires approval from the St. Joseph County Drainage Board and INDOT (Toll Road District). INDOT will solicit bids for an Asphalt Paving Project in the proposed project area in June 2002. INDOT approves of the proposed project and would like to include it within their Asphalt Paving Project (Appendix D, subsection 1).

3.9.4 Landowner Agreements

The project will not affect any landowners other than the Toll Road. INDOT approves of the proposed project (See 3.9.3 above). Appendix D, subsection 1 contains a letter of communication between INDOT and New.

3.9.5 Social Costs

There are no unusual social costs of completing the project.

3.9.6 Environmental Assessment

J.F. New & Associates inventoried the plants along the existing slope. The plant community consists of reed canary grass, fescue, wild carrot, poison ivy, yarrow, and other common weedy species. Runde (1994) monitored fish and macroinvertebrates just downstream at Juday Creek's intersection with Bittersweet Road (Runde, 1994). The study found no ETR species that might be affected by work upstream. The project is expected to positively benefit fish, macroinvertebrates, and plants by reducing the sediment load to the creek, providing more permanent cover on the slopes, and reintroducing native plant species to an area that they previously inhabited.

3.9.7 Cost Estimate

The probable cost of construction for the regraded slope/bank stabilization is $81,300 (Table 13).

TABLE 13. Regraded slope/bank stabilization cost estimate.

Item	Cost	Unit	Quantity	Total
Excavation/hauling	$8.50	Cubic. yard	5,300	$45,050
Seeding	$2,500	Lump sum	1	$2,500
Straw blanket	$0.50	Per roll (installed)	32,400	$16,200
Traffic control	$2,500	Lump sum	1	$2,500
Mobilization/demobilization	$1,500	Lump sum	1	$1,500
Construction sub-total				**$67,750**
Contingency	20%	Construction	$67,750	$13,550
Total				**$81,300**

4.0 SUMMARY OF COST ESTIMATES, SCHEDULE, AND FUNDING

Nine proposed projects have been recommended to improve water quality and habitat within Juday Creek. Table 14 lists cost estimates for each of the recommended restoration projects outlined in previous sections of this feasibility report. Table 15 displays a schedule for designing and implementing each of the proposed projects. Table 16 lists the potential funding sources for each proposed project. Table 17 lists all potential funding sources and contact information.

TABLE 14. Summary of project budgets.

Project	Report Section	Construction	Services	Engineering	Contingency	Total
Stabilization/habitat improvement west of Brooktrails Drive	3.1	$71,150	$7,115	$10,672	$17,787	**$106,724**
Erosion control at Kenilworth Road	3.2	$750	-	-	-	**$750**
Stream reroute/wetland filter (southeast side of Interstate 80/90 at US 933)	3.3	$84,000	$8,400	$25,200	$21,000	**$138,600**
Stream reconstruction/wetland filter between Ironwood and Douglas Roads	3.4	$238,190	$23,819	$47,638	$59,547	**$369,194**
Pond fill/constructed stream channel (Douglas Road east of Ironwood)	3.5	$46,000	$4,600	$6,900	$13,800	**$71,300**
Habitat improvement from Edison Lakes Parkway to Fir Road	3.6	$101,000	$10,100	$15,150	$20,200	**$146,450**
30-foot filter strips from Capitol Avenue to Interstate 80/90	3.7	$21,120	-	-	-	**$21,120**
Infiltration trench on south side of interstate 80/90	3.8	$7,975	-	-	$1,595	**$9,570**
Regraded slope/bank stabilization of ditch north of Interstate 80/90	3.9	$67,750	-	-	$13,550	**$81,300**
Total		**$637,935**	**$54,034**	**$93,650**	**$147,479**	**$945,008**

TABLE 15. Proposed project schedules.

Project	2002				2003				2004			
Quarter	1	2	3	4	1	2	3	4	1	2	3	4
Stabilization/habitat improvement west of Brooktrails Drive	G			D	P	C						
Erosion control at Kenilworth Road	D	C										
Stream reroute/wetland filter (southeast side of Interstate 80/90 at US 933)			G				D	P		C		
Stream reconstruction between Ironwood and Douglas Roads			G		D	P			C			
Pond fill/constructed stream channel (Douglas Road east of Ironwood)					G			D	P		C	
Habitat improvement from Edison Lakes Parkway to Fir Road		G	D	P		C						
30-foot filter strips from Capitol Avenue to Interstate 80/90	C											
Swale excavation/infiltration trench on south side of Interstate 80/90		D	C									
Regraded slope/bank stabilization of ditch north of Interstate 80/90		D	C									

G = Grant Application
D = Design
P = Permitting
C = Construction

TABLE 16. Appropriate funding sources for each project.

Project Description	319 Grant	LARE	USFWS	Other Grants	Drainage Board Match	Private Organizations or Individuals	Total
Stabilization/habitat improvement west of Brooktrails Drive		75% @ $80,043			25% @ $26,681		**$106,724**
Erosion control at Kenilworth Road					$750		**$750**
Stream reroute/wetland filter (southeast side of Interstate 80/90 at US 933)	75% @ $103,950				25% @ $34,650		**$138,600**
Stream reconstruction between Ironwood and Douglas Roads	60% @ $221,516	30% @ $110,758				10% @ $36,919	**$369,194**
Pond fill/constructed stream channel (Douglas Road east of Ironwood)		75% @ $53,475			25% @ $17,825		**$71,300**
Habitat improvement from Edison Lakes Parkway to Fir Road			75% @ $109,837		25% @ $36,612		**$146,450**
30-foot filter strips from Capitol Avenue to Interstate 80/90				NRCS $21,120			**$21,120**
Infiltration trench on south side of Interstate 80/90						IDOT $9,570	**$9,570**
Regraded slope/bank stabilization of ditch north of Interstate 80/90						IDOT $81,300	**$81,300**
Total	**$325,466**	**$244,276**	**$109,837**	**$21,120**	**$116,518**	**$127,789**	**$945,008**

TABLE 17. Potential Funding Sources and Contact Information.

Grant Name	Name	Address	City	State	Zip	Phone	Internet Address
Lilly Endowment, Inc.	N/A	P.O. Box 88068	Indianapolis	IN	46208	317-924-5471	
Golden Eagle Grant	N/A	One Monument Circle	Indianapolis	IN	46206-1595	317-261-8261	http://www.ipalco.com
Nina Mason Pulliam Charitable Trust	Harriet Ivey	135 N. Pennsylvania Suite 1200	Indianapolis	IN	46204	317-231-6075	http://www.nmpct.org
Central Indiana Community Foundation	N/A	615 N. Alabama St. Suite 119	Indianapolis	IN	46204	317-634-CICF	http://www.cicf.org/
Kosciusko County Foundation	Suzie Light	102 East Market St.	Warsaw	IN	46580	219-267-1901	http://www.kcfoudation.org
Wabash River Heritage Corridor	N/A	402 West Washington Rm. W271	Indianapolis	IN	46204-2739	317-232-4070	http://www.state.in.us/wrhcc/
NiSource Environmental Challenge	N/A	801 E. 86th St.	Merrillville	IN	46410	219-647-5246	http://www.nisouce.com/enviro/ecf.asp
Lake and River Enhancement Program	Jim Ray	402 W. Washington St.	Indianapolis	IN	46204	317-233-3870	http://www.state.in.us/dnr/soilcons/lare
Unity Foundation of LaPorte County	N/A	P.O. Box 527	Michigan City	MI	46361	219-879-0327	http://www.alco.orgs/unity
US Fish and Wildlife Service	Dan Sparks	620 S. Walker	Bloomington	IN	47403	812-334-4261	
IDEM 319 Grant	Jill Reinhart	100 N. Senate Ave.	Indianapolis	IN	4206-6015	888-233-7745	http://www.state.in.us/idem/owm

5.0 LITERATURE CITED

Cole Associates, Inc. 1995. Juday Creek Watershed Management Plan. Prepared for the St. Joseph County Drainage Board. 45 pp. plus appendices.

Cooke, G.D., E.B. Welch, S.A. Peterson, and P.R. Newroth. 1993. Restoration and management of lakes and reservoirs. Second edition. Lewis Publishers, Boca Raton, Florida.

Fowler, K.K. and J.T. Wilson. 1995. Characteristics, transport, and yield of sediment in Juday Creek, St. Joseph County, Indiana, 1993-94. U.S. Geological Survey Water-Resources Investigation Report 95-4135. 47 pp.

Hunter, C.J. 1991. Better Trout Habitat. Island Press, Washington DC. 320 pp.

J.F. New and Associates, unpublished. Stormwater Feasibility Study. Prepared for St. Joseph County Drainage Board. Sept. 1994. 22 pp. plus appendices.

J.F. New and Associates, unpublished. Biological Monitoring Report for the Williams Property. Prepared for Ralph Williams. Nov. 2001. 9 pp. plus appendices.

J.F. New and Associates, unpublished. Biological/Habitat Assessment Report. Prepared for the St. Joseph County Drainage Board. Oct. 2001. 17 pp. plus appendices.

Lamberti, G.A., and M.B. Berg. 1995. Invertebrates and other benthic features as indicators of environmental change in Juday Creek, Indiana. Natural Areas Journal 15:249-258.

Limno-Tech. 1991. Evaluation of potential impacts on Juday Creek from proposed detention basins. Prepared for the St. Joseph County Drainage Board. 15 pp. plus Appendices.

Omernik, J.M. and A.L. Gallant. 1988. Ecoregions of the upper Midwest States. U.S. Environmental Protection Agency, ERL. Corvallis, OR. EPA/600/3-88/037.

Runde, J.M. 1994. Subcontract for biological reconnaissance and evaluation of biological information on Juday Creek. University of Notre Dame, Dept. Biological Sciences. Final Report.

Silliman, S.E. 1994. Clean Water Act, Section 319 Grant. University of Notre Dame, Dept. Civil Engineering and Geological Sciences. Final Report.

Simon, T.P. 1997. Development of Index of Biotic Integrity expectations for the Ecoregions of Indiana. III. Northern Indiana Till Plain. U.S. Environmental Protection Agency. Region V. Water Division. Watershed and Non-Point Source Branch. Chicago. IL. EPA905/R-96/002.

Wayne, W.J. 1966. Ice and land: a review of the Tertiary and Pleistocene history of Indiana. In: Lindsey, A.A. (ed.) Natural Features of Indiana. Indiana Academy of Science, Indiana State Library, Indianapolis, Indiana, p. 21-39.